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ABSTRACT

This document presents the mathematics curriculum framework of the Connecticut State Department of Education. Program goals are presented before the 10 K-12 content standards for mathematics. Each content standard's performance standards are listed separately for grades K-4, 5-8, and 9-12. (ASK)

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MATHEMATICS CURRICULUM FRAMEWORK

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Connecticut State Department of Education
Division of Teaching and Learning
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MATHEMATICS

By the end of Grade 12, students will apply proficiently a range of numerical, algebraic, geometric and statistical concepts and skills to formulate, analyze and solve real-world problems; to facilitate inquiry and the exploration of real-world phenomena; and to support continued development and appreciation of mathematics as a discipline.

PROGRAM GOALS

As a result of education in Grades K-12, students will:

- communicate numerical, geometric, algebraic and statistical ideas orally and in written form with models, pictures, graphs and mathematical symbols, using paper and pencil, a variety of calculator displays, spreadsheets, graphing packages, word processing and other related computer software;
- use inductive and deductive reasoning to make, defend and evaluate conjectures and arguments, to justify assertions and verify tentative conclusions, and to solve mathematical problems;
- use mathematical skills and concepts to make and justify decisions and predictions, to identify patterns and trends, to pose questions from data and situations, and to formulate and solve problems;
- identify and use connections within mathematics to identify interrelationships and equivalent representations, to construct mathematical models, and to investigate and appreciate mathematical structure;
- use mathematical skills and concepts to describe and analyze data and measurements from other disciplines;
- select and use appropriate approaches and tools for solving computational, geometric and algebraic problems, including estimation, mental computation, guess and test, paper and pencil, calculators and computers with software for tabulating, charting, graphing, drawing and transforming data and images; and
- use mathematical skills and concepts with proficiency and confidence, and appreciate the power and utility of mathematics as a discipline and as a tool for solving problems.

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K-12 CONTENT STANDARDS

1.	**Number Sense**	Students will use numbers to count, measure, compare, order, scale, locate and label, and use a variety of numerical representations to present, interpret, communicate and connect various kinds of numerical information.
2.	**Operations**	Students will add, subtract, multiply and divide with whole numbers, fractions, decimals and integers, and develop strategies for selecting the appropriate computational and operational methods for solving problems.
3.	**Estimation and Approximation**	Students will make estimates and approximations, and judge the reasonableness of results.
4.	**Ratios, Proportions and Percents**	Students will use ratios, proportions and percents to represent relationships between quantities and measures and solve problems involving ratios, proportions and percents.
5.	**Measurement**	Students will make and use measurements in both customary and metric units to approximate, measure and compute length, area, volume, mass, temperature, angle and time.
6.	**Spatial Relationships and Geometry**	Students will analyze and use spatial relationships and basic concepts of geometry to construct, draw, describe and compare geometric models and their transformations, and use geometric relationships and patterns to solve problems.
7.	**Probability and Statistics**	Students will use basic concepts of probability and statistics to collect, organize, display and analyze data, simulate events and test hypotheses.
8.	**Patterns**	Students will discover, analyze, describe, extend and create patterns, and use patterns to describe mathematical and other real-world phenomena.
9.	**Algebra and Functions**	Students will use algebraic skills and concepts, including functions, to describe real-world phenomena symbolically and graphically, and to model quantitative change.
10.	**Discrete Mathematics**	Students will use the concepts and processes of discrete mathematics to analyze and model a variety of real-world situations that involve recurring relationships, sequences, networks, combinations and permutations.

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CONTENT STANDARD 1: Number Sense

Students will use numbers to count, measure, compare, order, scale, locate and label, and use a variety of numerical representations to present, interpret, communicate and connect various kinds of numerical information.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- use real-life experiences, physical materials and technology to construct meanings for whole numbers, commonly used fractions and decimals;
- understand our numeration system by modeling, counting, grouping and using place-value concepts;
- use numbers to count, as measures, labels and as indicators of location;
- use models and pictures to demonstrate understanding of equivalent forms of numbers;
- understand and use properties of numbers, including odd, even, ordinal and cardinal; and
- develop a sense of magnitude of numbers by ordering and comparing whole numbers, commonly used fractions, decimals and money amounts.

Educational experiences in **Grades 5-8** will assure that students:

- use real-life experiences, physical materials and technology to construct meanings for whole numbers, commonly used fractions, decimals and money amounts, and extend these understandings to construct meanings for integers, rational numbers, percents, exponents, roots, absolute value and scientific notation;
- model, represent and use numbers in a variety of equivalent forms (integer, fraction, decimal, percent, exponential and scientific notation) as they arise from real-world situations;
- use the equivalence of fractions, decimals and percents to select appropriate and efficient ways to write, order, compare, estimate and compute;

(continued)

Educational experiences in **Grades 9-12** will assure that students:

- use real-life experiences, physical materials and technology to construct meanings for rational and irrational numbers, including integers, percents and roots;
- use number sense and the properties of various subsets of real numbers to solve real-world problems;
- develop and use an intuitive sense of the magnitude of numbers (including very large and very small numbers) and relate them to place value and exponential forms; and
- select an appropriate form to represent and use numerical data (integer, fraction, decimal, ratio, percent, exponential, scientific notation, irrational, complex) as they arise from real-world situations involving magnitude, order, measures, labels, locations and scales.

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K-12 PERFORMANCE STANDARDS, continued

Educational experiences in **Grades 5-8** will assure that students:

- develop and use a sense of order and magnitude of fractions, decimals, integers, powers and roots; and
- develop and apply number theory concepts (primes, factors, multiples and divisibility rules), as appropriate, in various real-world problem situations.

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CONTENT STANDARD 2: Operations

Students will add, subtract, multiply and divide with whole numbers, fractions, decimals and integers and develop strategies for selecting the appropriate computational and operational methods for solving problems.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- develop meaning for the operations by modeling, comparing and discussing a variety of problem situations;
- develop proficiency with basic addition, subtraction, multiplication and division facts through the use of a variety of strategies and contexts;
- use informal language, mathematical language and symbols to relate problem situations to operations;
- recognize that any one operation can be used to represent diverse problem situations, e.g., subtraction can be used in "take away," as well as comparison, situations;
- construct, use and explain a variety of procedures for performing whole number calculations; and
- understand and use relationships among operations, e.g., multiplication is repetitive addition; multiplication is the opposite of division.

Educational experiences in **Grades 5-8** will assure that students:

- maintain proficiency with basic addition, subtraction, multiplication and division facts through the use of a variety of strategies and contexts;
- develop, use and explain procedures for performing calculations with whole numbers, decimals, fractions and integers;
- understand the concepts of powers and roots, and apply them in problem situations;
- select and use an appropriate method for computing from among mental math, estimation, paper-and-pencil and calculator methods; and
- use relationships among operations and properties of operations (associative, commutative and distributive) as well as order of operations and inverses to simplify computations.

Educational experiences in **Grades 9-12** will assure that students:

- use arithmetic operations to solve problems encountered in everyday consumer situations;
- apply and explain procedures for performing calculations with whole numbers, decimals, fractions and integers;
- use appropriate methods for computing, including mental math, estimation, paper-and-pencil and calculator methods;
- use field properties and the relationship between operations and their inverses to justify mathematical procedures; and
- use absolute value, powers and roots; explore and use negative exponents on integers.

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CONTENT STANDARD 3: Estimation and Approximation

Students will make estimates and approximations, and judge the reasonableness of results.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- explore, construct and use a variety of estimation strategies;
- recognize when estimation is appropriate and understand the usefulness of an estimate as distinct from an exact answer;
- use estimation to determine the reasonableness of an answer;
- visually estimate length, area, volume and angle using various referents; and
- apply estimation when working with quantities, measures and problems.

Educational experiences in **Grades 5-8** will assure that students:

- develop, apply and explain a variety of estimation strategies in problem situations involving quantities and measures;
- use estimation to predict outcomes and determine reasonableness of results;
- recognize when estimation is appropriate and understand the usefulness of an estimate as distinct from an exact answer; and
- determine whether a given estimate is an overestimate or underestimate.

Educational experiences in **Grades 9-12** will assure that students:

- assess the reasonableness of answers to problems arrived at using pencil-and-paper techniques, mental math, formulas, calculators or computers;
- develop, use and apply a variety of estimation strategies in problem situations;
- make reasonable estimates of the values of formulas, functions and roots; and
- recognize the limitations of estimation and assess the amount of error resulting from estimation.

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CONTENT STANDARD 4: Ratios, Proportions and Percents

Students will use ratios, proportions and percents to represent relationships between quantities and measures and solve problems involving ratios, proportions and percents.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- describe simple ratios when comparing quantities.

Educational experiences in **Grades 5-8** will assure that students:

- understand and use ratios, proportions and percents in a wide variety of situations;
- develop, apply and explain methods for solving problems involving proportions and percents;
- use and differentiate between fractional parts and ratios when comparing quantities; and
- use dimensional analysis to identify and find equivalent rates.

Educational experiences in **Grades 9-12** will assure that students:

- understand and explain the need for proportions and percents;
- use ratios, proportions and percents to solve real-world problems;
- use dimensional analysis and equivalent rates to solve problems;
- describe direct and indirect variation and apply them to numerical, geometric and algebraic models and related problems; and
- describe trigonometric ratios and apply them to measuring triangles.

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CONTENT STANDARD 5: Measurement

Students will make and use measurements in both customary and metric units to approximate, measure and compute length, area, volume, mass, temperature, angle and time.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- use and describe measures of length, distance, capacity, mass, area, volume, time, temperature and angle;
- compare and order objects according to some measurable attribute;
- develop and use personal referents, such as fingers and arm spans, as estimates for standard units of measure; and
- select and use appropriate standard and nonstandard units of measurement to solve problems.

Educational experiences in **Grades 5-8** will assure that students:

- estimate, make and use measurements to describe and compare phenomena, and explore the structure and use of systems of measurement, including converting units within systems;
- select and use appropriate measurement units and tools to make measurements to the degree of accuracy required by the situation;
- solve problems involving the concept of, calculation of, and relationships among length, perimeter, area, volume, angle measure, capacity, weight, mass and temperature; and
- develop and use formulas and procedures for solving measurement problems.

Educational experiences in **Grades 9-12** will assure that students:

- extend, apply and formalize understandings of measurement, including strategies for determining perimeters, areas and volumes, and the dimensionality relationships among them;
- describe and apply the effect of a change in length on the area and volume of an object;
- choose appropriate tools and techniques to measure quantities to specified degrees of precision and accuracy;
- use techniques of algebra, geometry and trigonometry to measure quantities indirectly; and
- use and create scales and calibrations to solve problems involving measurement.

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CONTENT STANDARD 6: Spatial Relationships and Geometry

Students will analyze and use spatial relationships and basic concepts of geometry to construct, draw, describe and compare geometric models and their transformations, and use geometric relationships and patterns to solve problems.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- describe, model, draw and classify shapes;
- investigate and predict the results of combining, subdividing and changing shapes;
- identify and use geometric shapes in various orientations, including rotations, reflections and translations;
- use real-life experiences, concrete objects and technology to explore and understand properties of 2- and 3-dimensional geometric shapes; and
- explore relationships among and properties of shapes, such as congruence, similarity and symmetry.

Educational experiences in **Grades 5-8** will assure that students:

- investigate, explore and describe the geometry in nature and real-world applications;
- identify, visualize, model, describe and compare properties of and relationships among 2- and 3-dimensional shapes;
- describe and use fundamental concepts and properties of, and relationships among, points, lines, planes, angles and shapes, including incidence, parallelism, perpendicularity, congruence, similarity and the Pythagorean theorem;
- construct, analyze and apply the effects of reflections, translations, rotations and dilations on various shapes;
- relate 2- and 3-dimensional geometry using shadows, perspectives, projections and maps; and
- solve real-world problems using geometric concepts.

Educational experiences in **Grades 9-12** will assure that students:

- use transformations, coordinates and vectors and appropriate computer software to explore and develop an understanding of Euclidean geometry;
- deduce properties of, and relationships among, figures from given assumptions;
- develop an understanding of an axiomatic system through geometric investigations, making conjectures, formulating arguments and constructing proofs;
- understand and analyze the geometry of three-dimensional shapes and their cross-sections;
- solve real-world and mathematical problems using geometric models; and
- interpret algebraic equations and inequalities geometrically, and describe geometric objects algebraically.

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CONTENT STANDARD 7: Probability and Statistics

Students will use basic concepts of probability and statistics to collect, organize, display and analyze data, simulate events and test hypotheses.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- pose questions, make predictions and solve problems that involve collecting, organizing and analyzing data;
- construct, read and interpret displays of data such as pictographs and bar and circle graphs;
- make inferences and formulate hypotheses based on data;
- generate and analyze data obtained from such chance devices as spinners and dice;
- develop intuition about the probability of various real-world events; and
- make predictions that are based on intuitive and experimental probabilities.

Educational experiences in **Grades 5-8** will assure that students:

- make conjectures; design simulations and samplings; generate, collect, organize and analyze data; and represent the data in tables, charts, graphs and creative data displays;
- make inferences and formulate and evaluate hypotheses and conclusions based on data from tables, charts and graphs;
- describe the shape of the data using range, outliers, and measures of central tendency, including mean, median and mode;
- select and construct appropriate graphical representations and measures of central tendency for sets of data;
- determine the probability of simple and compound events;
- model probabilistic situations using both simulations and theoretical methods;

(continued)

Educational experiences in **Grades 9-12** will assure that students:

- estimate probabilities, predict outcomes and test hypotheses using statistical techniques;
- design a sampling experiment, interpret the data, and recognize the role of sampling in statistical claims;
- use the law of large numbers to interpret data from a sample of a particular size;
- select appropriate measures of central tendency, dispersion and correlation;
- design and conduct a statistical experiment and interpret its results;
- draw conclusions from data and identify fallacious arguments or claims;
- use scatterplots and curve-fitting techniques to interpolate and predict from data;

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K-12 PERFORMANCE STANDARDS, continued

Educational experiences in **Grades 5-8** will assure that students:

- make predictions that are based on experimental and theoretical probabilities; and
- draw conclusions from data and identify fallacious arguments or claims.

Educational experiences in **Grades 9-12** will assure that students:

- use relative frequency and probability to represent and solve problems involving uncertainty; and
- use simulations to estimate probabilities.

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CONTENT STANDARD 8: Patterns

Students will discover, analyze, describe, extend and create patterns and use patterns to describe mathematical and other real-world phenomena.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- reproduce, extend, describe and create patterns and sequences using a variety of materials and attributes;
- use tables and graphs to display pattern data and explore a variety of ways to write rules that describe patterns and relationships; and
- develop and test generalizations based on observations of patterns and relationships.

Educational experiences in **Grades 5-8** will assure that students:

- describe, analyze, create and extend a wide variety of patterns;
- represent and describe mathematical relationships using tables, rules, simple equations and graphs;
- use patterns and relationships to identify the nth term in a sequence;
- construct and analyze tables and graphs to identify patterns and relationships; and
- use patterns and relationships to represent and solve problems.

Educational experiences in **Grades 9-12** will assure that students:

- identify, describe and generalize numerical and spatial patterns;
- identify, describe and generalize patterns from data and identify and analyze patterns of change; and
- predict and describe patterns produced by iterations, approximations, limits and fractals.

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CONTENT STANDARD 9: Algebra and Functions

Students will use algebraic skills and concepts, including functions, to describe real-world phenomena symbolically and graphically, and to model quantitative change.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- represent numerical situations using variables, expressions, equations and inequalities; and
- write and solve number sentences that describe real-life situations.

Educational experiences in **Grades 5-8** will assure that students:

- use variables, expressions, equations and inequalities to describe and represent numerical situations;
- use concrete materials, tables, graphs, verbal rules and symbolic expressions to represent situations and patterns;
- analyze functional relationships to explain how a change in one quantity is associated with a change in another;
- construct and interpret data points on number lines and the coordinate plane; and
- solve simple linear equations using concrete, informal, graphical, tabular and formal methods.

Educational experiences in **Grades 9-12** will assure that students:

- model and solve problems that involve varying quantities with variables, expressions, equations, inequalities, absolute values, vectors and matrices;
- model real-world phenomena using polynomial, rational, trigonometric, logarithmic and exponential functions, noting restricted domains;
- analyze the effect of parametric changes on the graphs of functions;
- translate among and use tabular, symbolic and graphical representations of equations, inequalities and functions;
- develop, explain, use and analyze procedures for operating on algebraic expressions and matrices; and
- solve equations and inequalities using graphing calculators and computers as well as appropriate paper-and-pencil techniques.

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CONTENT STANDARD 10: Discrete Mathematics

Students will use the concepts and processes of discrete mathematics to analyze and model a variety of real-world situations that involve recurring relationships, sequences, networks, combinations and permutations.

K-12 PERFORMANCE STANDARDS

Educational experiences in **Grades K-4** will assure that students:

- classify data according to attributes;
- solve simple counting problems;
- use diagrams and models of simple networks that represent everyday situations;
- identify and investigate sequences; and
- follow, devise and describe practical algorithmic procedures.

Educational experiences in **Grades 5-8** will assure that students:

- use systemic listing and counting strategies, including simple combinations and permutations;
- use recursive processes, including iteration, to explore and solve problems; and
- devise, describe and test algorithms for solving optimization problems.

Educational experiences in **Grades 9-12** will assure that students:

- represent problem situations using finite graphs, matrices, sequences and recurrence relations;
- develop, analyze, describe, invent and test algorithms;
- define and use permutations, combinations, mathematical induction and recursion to solve combinatorial and algorithmic problems; and
- understand and use appropriate strategies to solve optimization problems.

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